Oil and its influence on the creation of a sustainable society: A systematic literature review

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Abstract

Purpose: The aim of this work is to analyze the petroleum industry from the perspective of sustainability, taking into account its three dimensions: economic, environmental and social. Likewise, the objective is to identify and propose factors of sustainability, in other words, categories or subdivisions that allow us to analyze in greater detail the interactions and the effects of this industry on society, which must be evaluated in each of the three dimensions for the oil sector.

Design/methodology: This research was carried out by means of a systematic review of the literature, with a qualitative focus of an analytic/interpretive nature. A four-phase protocol was used for the search, using the guidelines of the PRISMA statement as a reference. This protocol describes the article selection criteria, search strategy, data extraction and procedures and tools used for the analysis.

Findings: The review reveals the need to establish a consensus on the sustainability factors that must be evaluated in each of the dimensions within the oil sector, given that the results of the search show that there is no clear definition or correlation with regard to the environmental, social and economic impact in the oil-producing regions. Most of the works identified were designed as case studies and a large majority of the results of the studies are contradictory, even showing adverse effects, while others fail to identify any hazards.

Originality/value: The most relevant contribution of this work is related to the identification of specific sustainability factors for the oil industry, which make it possible to conduct a comprehensive analysis of their influence on the three dimensions of sustainability, namely economic development, environmental aspects and social aspects. This classification according to factors is important in order to provide a cross-cutting conceptual framework that is applicable to any region or situation where the problems are being analyzed that derive from oil exploitation.

Keywords: Oil industry, Environmental impact, Social development, Sustainable development, Public health

Jel Codes: O14, O15, O20, O33

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1. Introduction

Energy is fundamental for human activity and while various energy sources exist, the industrial use of oil has a radical influence on the evolution of society. Over time, oil has become a vital source of energy, fuel and raw materials for many different industries. For this reason, the worldwide demand for crude oil continuously increases at an annual rate of around 1.8 %, with forecasts for the oil demand in 2021 of 96.7 million barrels per day (mbd), which represents an increase of 5.7 mbd as compared to 2020, according to the International Energy Agency (IEA, 2021). It should be pointed out that natural gas and petroleum are the world's main energy sources, with oil accounting for 33.1% and natural gas representing 21.9% of the energy demand around the world (Abbaszadeh, Maleki, Alipour & Maman, 2013).

In spite of its undeniable benefit for the progress of modern society, the oil sector is widely questioned, as its exploitation and consumption generates controversy as the result of its impact on the economic development of the production regions, effects of ecosystems, climate change, social aspects, impact on technological development and geopolitical matters (Hall, Tharakan, Hallock, Cleveland & Jefferson, 2003). It is important to stress that oil and natural gas are energy resources that play a strategic role in political and economic issues around the world (Ariga, 2002).

In addition, oil is a non-renewable energy source and the conventional sources of crude oil are being depleted, making it necessary to use non-conventional hydrocarbons, in other words, heavy oil, which is of poorer quality and presents greater technological challenges. Reliance on this type of crude oil is mandatory in order to continue with our current lifestyle, which poses new challenges for society, as it requires a technological change in order to access these resources in a sustainable and economically feasible manner.

There are currently very polarized opinions about the desirability of the oil industry. The rigid positions held by scholars, politicians and the public opinion reflect the complexity of the issue, as well as the need to have the most information possible in order to make good decisions about its use and define its future. This disparity of opinions also evidences how the current information is fragmented and many times biased, preventing an understanding of the situation from a holistic, impartial perspective.

Analyzing the oil sector from a sustainability perspective is an appropriate approach in order to establish its desirability for society. The Brundtland Report, issued in 1987 at the United Nations conference on development and the environment, defines sustainability as that which "*meets the needs of the present without compromising the needs of future generations*". In general terms, the concept includes three main dimensions: economic, social and environmental. The economic dimension seeks to improve human well-being through increased consumption of goods and services. The environmental dimension focuses on protecting the integrity and resilience of ecological systems. The social dimension emphasizes the enrichment of human relations and the achievement of individual and group aspirations (Munasinghe, 2002).

Evidence can be found in the literature of studies that consider sustainability in the oil sector (e.g., Ahmed, Mahalik & Shahbaz, 2016; Abou-Ali & Abdelfattah, 2013; Hall et al., 2003; Munasinghe, 2002; Munasinghe, 2001), however, these studies are focused on very specific topics that do not allow for this global perspective. Only Munasinghe (2002) carries out a meta-marco transdisciplinary study of sustainable development that is inclusive, balanced, heuristic and practical, through the analysis of seven case studies applied to energy problems. However, the literature reflects a rather partial view of the oil industry, and it would be important to have a holistic analysis of the strengths and weaknesses of this industry from a sustainability perspective. Another drawback is that the three dimensions mentioned are very general and require a disaggregation of the different factors of sustainability, understood in this case as categories or subdivisions that make it possible to analyze the interactions and effects of this industry on society in greater detail. Little has been studied and written about these factors.

With regard to the above, the present article presents a characterization of the oil sector, taking into account the three dimensions of sustainability (economic, environmental and social), as well as identifying and proposing sustainability factors that must be evaluated in each of the dimensions for the oil sector, in order to contribute to

giving future studies uniform criteria that can be applied to any region with a socio-environmental conflict derived from the oil industry. This research was carried out by means of a systematic literature review.

The article is structured as follows: The following section presents the methodology, which describes the research design, as well as the identification and selection of documents. The second section provides a description of the findings from the literature review and the factors that were identified. The document ends with the sections related to the discussion, conclusions and future works.

2. Methodology

2.1. Method

The work was carried out by means of a systematic literature review with a qualitative focus of an interpretive-analytical nature, including the content analysis of secondary information. A diagram was designed for the search based on the proposals for systematic literature reviews by the authors Tranfield, Denyer and Smart (2003) and Snyder (2019). The article selection protocol was structured into four stages, based on the proposal by PRISMA (Urrútia & Bonfill, 2010). The first stage is related to the identification of the topics of interest. The second carried out the filtering process to limit the scope of the search. The third stage determined the eligibility of the most important articles and finally, the fourth stage determined the final inclusion of the "*Key papers*" (seeFigure1). Two researchers participated in the process for the selection and coding consensus. No date of publication range was set in order to obtain a broader spectrum during the document search.

2.2. Sample and data collection

The topics of interest were identified in the first stage by means of an initial search for documents related to the impact of the oil industry on the dimensions of sustainability, through key words related to the 3 dimensions of sustainability specified in the guide for drafting sustainability reports (GRI, 2021). In addition, words related to the oil industry were also annexed, as it is the sector of interest in the study and for its impact throughout history. The document search was carried out in the SCOPUS database, using the following expression:

> *(ALL(petroleum)ANDALL(economicANDimpact)ANDALL(socialANDimpact)ANDALL(environmentalAND impact)ANDALL(growth)ANDALL(history).*

A total of 2,308 documents were identified in the initial search; these were then examined and it was determined that the information was very disperse and a large percentage did not fall under the specific topic of interest; the search equation was then refined, adding the term (Oil extraction), which successfully reduced the documents selected to a total of 537. The results produced by this new search showed a closer relationship to the topic of the impact by the oil sector on the sustainability dimensions. During the second stage, the scope of the topics of interest was limited, and as a result filtering processes were used according to the inclusion and exclusion criteria shown inTable 1. As the result of this stage, 335 articles were identified. In the eligibility stage, the most important articles were identified. After scanning the summaries of the complete documents, 14 articles were identified. These documents are: Ahmed, Asghar, Malik and Nawaz (2020), Norouzi, Fani and Ziarani (2020), Singh, Bhardwaj, Arya and Khatri (2020), Sun, Ak, Serener and Xiong, (2020), Topcu, Altinoz and Aslan (2020), Johnston, Lim and Roh (2019), Zaidi, Wei, Gedikli, Zafar, Hou and Iftikhar (2019), Ahmed et al.(2016), Palazuelos, (2016), Zou, Zhao, Zhang and Xiong (2016), Chapman, Tonts and Plummer (2015), Kotey and Rolfe (2014), Hall et al. (2003) and Munasinghe (1993).

Inclusion criteria	Exclusion criteria
IC1. Articles that considered any of the sustainability dimensions, specifically for the oil sector.	EC1. Articles that did not address the oil sector, even though they did consider sustainability dimensions.
IC2. Economic factors related to: economic growth, detrimental effects on natural resources, oil reserves, corruption, oil management and energy strategies, innovation and technological development.	EC2. Articles in languages other than English. EC3. Articles for which the full text was not found. EC4. Articles that did not address at least one of the sustainability dimensions.
IC3. Environmental factors related to: environmental management, environmental pollution, oil spills, and impacts on public health.	EC5. Articles that address factors other than those identified in the inclusion criteria.
IC4. Social factors related to: characteristics of society, culture, demographic change, economic activity, employment.	

Table 1. Inclusion and exclusion criteria

The introductions and conclusions of the 14 Key papers were scanned. In spite of the fact that the documents were related to the topic, the need was subsequently identified to extend the search for each of the three dimensions of analysis, and thus each of the dimensions was considered intensively and separately. As a result, a search was started in *Science Direct* for the three specific equations according to dimension, in order to ensure that full-text documents were identified. The following equation was used:

> *Science Direct 1 (sd1): (ALL(oil AND industry)AND ALL (petroleum) AND ALL (economic AND growth) AND ALL (curse) AND ALL (natural AND resources) AND ALL (financial AND development) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO(OCTYPE, "re"))AND (LIMIT- TO(OA,"all")*

This equation was related to regional development (*oil industry, petroleum, economic growth, curse, natural resources, financial development*), resulting in a total of 33 documents, 31 of which were relevant. In addition, the following equation was considered:

> *Science Direct 2 (sd2): (ALL(oil AND industry)AND ALL (petroleum) AND ALL (environmental AND impact) AND ALL (Oil AND extraction) AND ALL (Contamination) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE,"re")) AND (LIMIT- TO (SUBJAREA,"ES").*

This equation (sd2) was based on environmental aspects (*oil industry, environmental impact, Oil extraction, Petroleum, Contamination, A review*), and produced 85 documents, 31 of which were associated with the purpose of the present research. Finally, the following equation was used:

> *Science Direct 3 (sd3): (ALL(oil AND industry)AND ALL (petroleum) AND ALL (geopolitical) AND ALL (culture) AND ALL (Human AND capital) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")).*

The equation sd3 was focused on social aspects (*oil industry, petroleum, geopolitical, culture, human capital*), resulting in 81 documents, of which 35 were relevant. To determine whether a study was relevant or not, the inclusion criteria from Table 1 were used.

Finally, the documents from the different searches were integrated in the fourth stage, filtering them according to a full, more detailed reading of each document. The final database is made up of a total of 31 Key papers. Figure 1 shows the steps taken to obtain them. It should be clarified that the writing of this article considered additional references that are crucial to developing the topic.
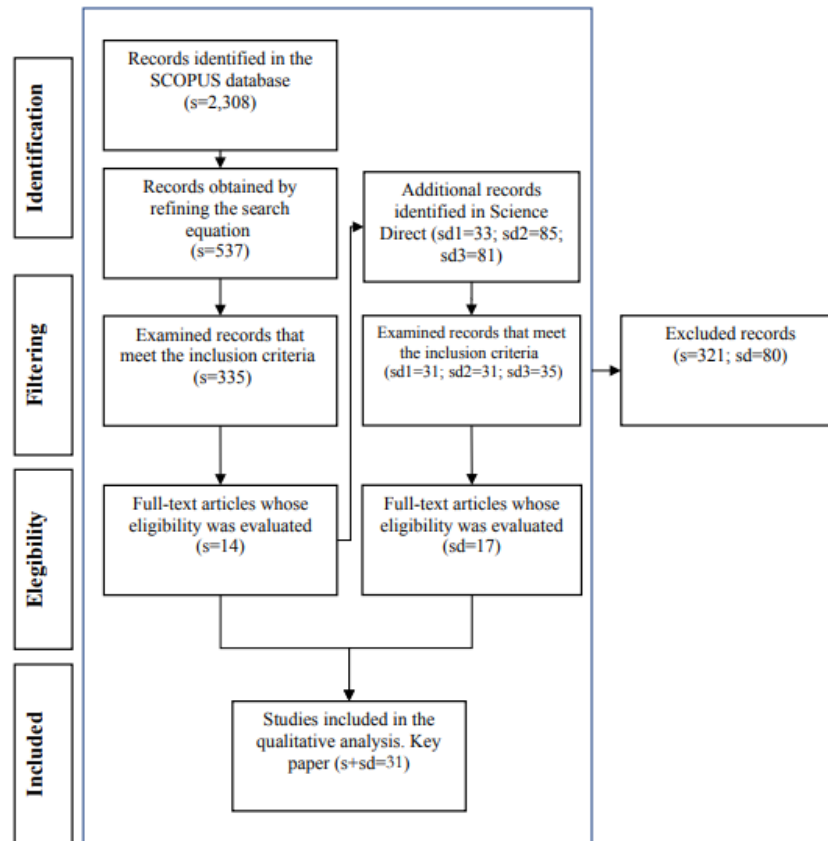
Figure 1. Diagram of the article selection process

The analysis and encoding of the information in the 31 articles were carried out while taking into account the three dimensions of sustainability: economic, environmental and social development. It should be stressed that each of the dimensions mentioned includes different factors.

3. Results the systematic literature review

The results of this systematic review have been organized according to the three dimensions of sustainability (economic, environmental and social). The goal is to determine the contributions, threats and weaknesses of the oil industry. As a product of the review, for each of the three dimensions, different sustainability factors have been identified, on which most of the authors have concentrated their efforts. The disaggregation of the dimensions into sustainability factors facilitates the approach to the topic, allowing critical aspects to be identified and providing a starting point to make future studies more holistic, thus permitting an expanded analysis of the problem. Appendix A shows the details of the Key papers analyzed, describing the dimensions and the sustainability factors that have been identified.

3.1. Economic dimension

Economic growth, one of the main objectives of any country, is described as the increase in market value of the goods produced during a certain period. Traditionally, the studies investigating the basic dynamics of growth take into account determinants such as labor, accumulated capital, natural resources, human capital and technological development, among other aspects (Topcu et al., 2020). Oil thus plays a crucial role in the economy, given that it is one of the most representative natural resources. There is a strong connection between energy (derived from hydrocarbons) and the economic activity of most of the industrialized economies (Hall, Lindenberger, Kümmel, Kroeger & Eichhorn, 2001), as well as that of developing economies (Tharakan, Kroeger & Hall, 2001).

The importance of hydrocarbons is evident in the energy sector, although it is also very important in obtaining fuels and byproducts for the chemical and petrochemical industries (Hawdon, 1985). Norouzi et al. (2020) identified several uses for products and derivatives from the oil and gas industry, which will be vital and difficult

to replace in future decades. The chain of derivatives, intermediate and finished products, are capable of making up for the demand induced by the modification in consumption patterns, and of revitalizing the production and export activities of all types of products (Bahrami & Abbaszadeh, 2013).

The main factors that affect the energy demand are the increase in population and the type of consumers, which can increase or decrease the demand for oil (IRES, 2011). Likewise, technological advances in energy efficiency and new alternative energy sources also influence the demand for oil and gas (Mohammadnejad, Ghazvini, Mahlia & Andriyana, 2011). The sustainability of the oil sector is a very important topic, as there has always been a strong demand and society depends on a continuous supply of crude oil. There are also challenges posed by this type of industry, which if not analyzed and considered, can generate great economic imbalances.

Some oil-producing countries do not necessarily have strong economies, and they have medium to high levels of human development indicators. In spite of its irrefutable role in the development of modern society, the oil industry is a widely questioned sector, given that the exploitation and consumption of oil is controversial due to the negative impact observed on the economic growth of some of the oil-producing regions, so much so that some authors have proposed and studied the hypothesis of the "resource curse", which points to an adverse effect stemming from the income from natural resources in the financial development of the producing region (Sun et al., 2020).

The function of natural resources in the economic growth is a critical topic with a long history and undeniable significance. However, when countries rich in natural resources have lower growth rates, this situation is explained from the framework of the "resource curse or Dutch disease hypothesis" (Topcu et al., 2020). This hypothesis is based on the study by Sachs and Warner (2001).

According to Gylfason (2001), the inverse relationship between economic growth and the abundance of natural resources occurs because a resource-based economy excludes physical, human and institutional capital. The main mechanism begins with the export of natural resources, increasing the currency entering the country and the value of the national currency, thus increasing imports and decreasing the domestic product. This channels investments in the country towards the energy mining sector to the detriment of other sectors (Corden, 1984). Furthermore, Gylfason (2001) introduces four main channels for transmitting abundant natural resources to the atrophied economic development: the Dutch disease, search for incomes, excessive confidence and neglecting of education. In this sense, the author proposes that the public expenditure on education, the years of schooling and the percentage of registration in secondary school show an inverse relationship with regard to the participation of the natural capital in the national wealth; in this regard, natural capital seems to displace human capital, slowing the pace of economic development.

Over the last two decades, the literature has examined oil-rich economies, finding a negative relationship between wealth in resources and economic growth (Robinson, Torvik & Verdier, 2006). Amongst the various theoretical explanations presented in the literature, the most common one is that economies rich in resources have a tendency to depend on them (Dubé & Polèse, 2015; Williams, 2011).

Economic growth since 1965 has varied inversely to the participation of natural capital in the natural wealth among some countries (Gylfason, 2001). Researchers who study development have debated for quite some time about the structural causes of the "shortfalls" in economies in which the production and export capacity is based primarily on agricultural or mineral resources. The early studies in the 1950s sustained that these resources should be the basis of economic development, while other analyses from the 1960s argued that dependence on this wealth in resources impeded development. Following the oil crises of 1973 and 1979, a second generation of scholars emerged who emphasized the mechanisms that were characterized as being "rentier" (Palazuelos, 2016).

Other studies carried out in different geographical contexts back the findings of the negative impact of natural resources on economic growth. For example, Abou-Ali and Abdelfattah (2013) examined the validity of the resource curse between 1990 and 2017 in 62 countries. Satti, Farooq, Loganathan and Shahbaz (2014) examined the long-term cause and effect relationship between the abundance of natural resources and the low level of economic growth in Venezuela. On the other hand, Ahmed et al. (2016) analyzed the case of Iran, and the findings suggest that over the long term, natural resources impede economic growth. Xu, Xu, Chen and Che

(2016) studied the case of China on a regional level and concluded that the hypothesis was valid, given that they identified economic shortfalls. In the same sense, Kurniawan and Managi (2018) corroborated the hypothesis for Indonesia during the 1990-2014 period. Tiba (2019) studied 21 Sub-Saharan countries, and his results showed the validity of the hypothesis. In turn, Tiba and Frikha (2019) concluded that the abundance of natural resources had a negative effect on economic growth in 26 African countries. Sun et al. (2020) studied seven emerging economies (E−7), and their results evidenced the adverse effect of income from natural resources on financial development.

Other authors performed a critical analysis of the position of the natural resource curse and stated that the literature review showed a lack of evidence that would make it possible to generalize the results, given that only isolated cases have been presented, with no conclusive results (Ahmed et al., 2016). In this sense, Brunnschweiler and Bulte (2008) claim that the abundance of resources generates dependence, but it does not affect the proportion of economic growth. On the other hand, the results of Papyrakis and Gerlagh (2004) suggest that the abundance of resources only affects economic growth when considered in isolation.

Over time, the solidity of the methodology employed in studies on the resource curse has been called into question: these articles were based on statistical estimation processes that ignored the intertemporal dynamics and spatial effects, such as commercial and financial integration, while in terms of modeling, they overlooked manpower, financial capital and trade openness. In addition, the name of this branch of literature itself is misleading, since the results of the articles suggest that there is no curse, rather simply good or bad management of the natural resources (Moisé, 2020).

A group of authors was also identified who have indicated contrary patterns, in other words, those that reject the resource curse hypothesis. More recent studies, such as that by Zaidi et al. (2019), examined the impact of globalization, natural resources and human capital on financial development, economic growth and capital in the countries belonging to the Organisation for Economic Co-operation and Development (OCDE). Their results suggest a significant positive impact of globalization, natural resources and human capital on financial development. The economic growth and the gross formation of fixed capital also have a positive impact on the financial development. In agreement with the previous results, Topcu et al. (2020) analyzed the effects of the natural resources, energy consumption and the gross accumulation of capital on the economic growth of 124 countries. These findings obtained from a global sample confirmed that the natural resources, energy consumption and the gross formation of capital have different effects on the GDP, according to the levels of income in the countries (high, medium, low).

Cavalcanti, Mohaddes and Raissi (2011) examined 53 countries, finding a nexus between oil and short-term positive economic growth. Hamdi and Sbia (2013) examined the relationships between oil income, public expenditure and economic growth in the Kingdom of Bahrain, and the results suggested that oil income is the main source of growth and financing of public expenditure. Pradhan, Arvin, Hall and Nair (2016) examined the relationship of natural resources and economic growth in the 43 countries belonging to the Organisation of Islamic Cooperation (OIC), revealing a significant positive impact on economic growth (Pradhan et al., 2016). Ben-Salha, Dachraoui and Sebri (2018) studied the links between the income from natural resources and the economic growth of countries with abundant resources during the 1970-2013 period. The findings reveal the blessing that natural resources present over the long term, even though this is not evident over the short term. Shahbaz, Destek, Okumus and Sinha, in turn, (2019) determined that in 35 countries, the abundance of natural resources fueled the economic growth during the period 1980–2005. Erdoğan, Yıldırım and Gedikli (2020) concluded that the increase by one unit in oil exports resulted in a 7% increase in economic growth. The study was conducted in select countries from the Next-11 for the period 1996 to 2016.

One advantage oil resources provide to countries is the possibility of diversifying the economy, since rich countries seek to diversify their economies by creating a competitive industrial sector with petrochemical and nanochemical products, and those from other derivative industries with greater added value. A study conducted by the Deloitte company provides proof of this, indicating that the development of oil recovery technologies and continuous improvement in terms of efficiency are among the most important factors for maintaining a competitive position in this field (WBGU, 2011).

Furthermore, the depletion of reserves is an extremely important matter, as it is a non-renewable energy source. For this reason, the availability of oil and other hydrocarbons is a fundamental aspect in the regional development of oil-producing countries. In order to evaluate the availability of oil, it is necessary to know: the quality and quantity of the reserves, the likely patterns of resource exploitation over time, and finally, who will reap the benefits from the oil. All these factors affect the economy of oil production and use (Hall et al., 2003).

Oil is made up by a large family of different hydrocarbons, the physical and chemical qualities of which reflect the different levels of natural maturity in their respective deposits (Tissot & Welte, 1978). The exploitation of "light" crude oils with a shorter chain has been achieved, as their deposits are easier to find and drill. These light crude oils are more valuable and require less energy to extract and refine and therefore generate greater profitability. Since they are a non-renewable resource, the depletion of light crude oil is imminent, and therefore has necessitated the exploitation of heavier, more viscous crude oils (Hall et al., 2003).

Hall et al. (2003) allege that the world is not about to run out of hydrocarbons, but that it will be difficult to obtain them at a low cost, because there are poor quality deposits and their drilling and processing will probably be more costly from a financial, energy, political and especially environmental perspective.

Norouzi et al. (2020) present the reports on the world's energy status, estimating that the oil supply will slowly expand and increase between 2015-2030. On the other hand, the demand for oil could drop due to alternative energy sources, in addition to the important reduction in prices, which would also affect its production.

Another relevant aspect is the generalized spreading of corruption in relation to natural resource management (Moisé, 2020). Corruption in the context of oil could easily become a significant scandal that involves the highest political levels. While it is true that investments in oil can generate immense earnings, it is also clear that the oil market is not reliable. This instability increases the risk that the investment would cause businesses to go bankrupt and governments to fall. The authoritarian governments of oil-producing countries often poorly manage the earnings from oil production, creating great inequalities through inadequate distribution.

Many studies analyze the management of oil resources and two different models have been proposed: the Dutch model and the Nigerian model. The first associated the effects of overdependence on the income and the price volatility with deindustrialization, and the second focused on corruption and revenue capture as a symptom of poor natural resource management (Moisé, 2020). The growth in the branch of literature related to oil resource management began to include other negative consequences derived from poor natural resource management, such as civil and ethnic conflicts and the brain drain caused by migrations. Khan, Hussain, Shahbaz, Yang and Jiao (2020) identified the positive effect on financial development of factors such as technological innovation, commercial openness and human capital in China. Zaidi et al.(2019), in turn, studied data from developing countries, and their results suggest a significant positive impact from globalization, natural resources and human talent on financial development on a host of variables over the long term. In this regard, the work by Abbaszadeh et al. (2013) examined the energy status in Iran and proposed the analysis of future oil scenarios. Finally, a comprehensive analysis was presented for achieving a secure and sustainable future in terms of the geopolitical, geoeconomic and geocultural situation. Yasmeen, Wang, Zameer and Solangi (2019) investigated the short- and long-term relationship between the fluctuation in oil prices and the growth of the real sector in Pakistan.

3.2. Environmental dimension

Sustainable development is related to the need to administer natural resources in a prudent manner, as the well-being of the human race ultimately depends on ecological services (Munasinghe, 2002). Munasinghe, Sunkel and Miguel (2001) explicitly address the relationship between growth, the environment and climate change, as well as their associations with development, equity and sustainability, respectively. The concept of sustainable development requires that countries use their natural resources in a rational manner while striving for economic development, and at the same time, they consider environmental quality to be a determining factor for societal well-being. The results from the work by Abou-Ali and Abdelfattah (2013) suggest that the way in which countries approach sustainability in the context of the MDGs (Millennium Development Goals) is negatively

affecting the quality of the environment. In this sense, the relationship between the abundance of natural resources and the deterioration of the ecosystems has important environmental implications.

Armeanu, Gherghina and Pasmangiu (2019) discovered that energy is a critical driver of social and economic progress, but the use of fossil fuel energy sources poses important challenges due to their negative environmental impacts. The mass use of fossil fuel energy sources is considered to be the root of ecological problems, such as local air and water pollution, together with climate change, which is harmful to both ecosystems and human health (Le & Nguyen, 2019). As civilization advances, there is an increased demand around the world for oil, as an energy source for heating, transportation and a raw material for the chemical industries (Singh et al., 2020).

In recent years, the ecological and environmental problems derived from waste water, gas emissions, toxic waste, the demand for natural resources and energy consumption caused by the use of coal, oil and other energy sources with a high carbon content have become increasingly more prominent (Zou et al., 2016). In order to tackle these problems, renewable energy technologies are being developed to minimize the consumption of fossil fuel energy (Armeanu et al., 2019). In addition, taking into account the sustained increase in the energy demand, other innovations of an environmental nature are being implemented. However, it will be many years before these technologies are ready, and they only partially solve the energy problem, since no replacement products for the supply of raw materials have been identified.

Tharakan et al. (2001) Demonstrated unprecedented economic and demographic growth in Asia over the last three decades. While conventional economic indicators have constantly increased, quality indicators of resources and the environment have deteriorated. In this sense, it is evident that economic growth in the future will depend on ensuring a more efficient use of natural resources and, at the same time, striving to reduce environmental impacts. Furthermore, Ahmed et al. (2020) researched the effect of the abundance of natural resources, human capital and urbanization on the ecological footprint in China. The long-term results reveal that the income from natural resources increases the ecological footprint. Urbanization and economic growth contribute to environmental deterioration, while the human capital mitigates environmental deterioration.

With regard to pollutant emissions associated with oil drilling, research generally focuses on a specific medium, be it air, soil or water. The impact on the air quality of a sector near a drilling site is affected because the drilling process produces emissions of various hazardous atmospheric pollutants that are harmful to human health, including chemicals such as benzene, toluene, ethylbenzene, xylene, formaldehyde, hydrogen sulphide and methylene chloride (Field, Soltis & Murphy, 2014). The chemicals released into the air include toxic or carcinogenic compounds that are associated with reproductive harm (Stringfellow et al., 2017).

Soil pollution occurs when the drilling fluids are spilled during transport by trucks or waste water piping systems, defects in well casingor leaks from pipes from the tanks and/or waste pits (Pichtel, 2016). Different authors have identified a relationship with high concentrations of metals in the soil near oil fields, which can result in adverse effects for health. This is the case described in the work by Fu, Cui and Zang (2014), who analyzed a soil analysis for a Chinese oil field. Among their findings, they identified that cadmium (Cd) is the most bioavailable heavy metal in soils polluted by oil and the most dangerous for the ecosystem. Likewise, a study in Nigeria identified high concentrations of lead (Pb), cadmium (Cd), chromium (Cr) and zinc (Zn) (Asia, Jegede, Jegede, Ize-Iyamu & Bernard, 2007). Other studies have investigated the relationship between oil drilling and the presence of naturally radioactive materials (for example, 226Ra, 232Th and 40K) in surface soils (Rich & Crosby, 2013). The study by Ajayi and Dike (2016) shows concentrations of natural radionuclides in regions where active oil drilling is taking place. This suggests that this drilling leads to greater concentrations of radionuclides on the surface of the soil; however, the risk analyses for the population did not exceed the maximum allowable limit established by the International Commission on Radiological Protection (ICRP, 2000). Agbalagba, Avwiri and Chad-Umoreh (2012) found similar results in 10 Nigerian oil fields, but suggested possible long-term effects for field workers and residents near the site.

Several studies have evaluated the role oil drilling plays and its incidence on the quality of surface and underground waters. Some authors concluded that oil drilling activities can affect the chemical composition of surface waters, greatly deteriorating their quality, as the result of waste water spills through leaks, discharges or

filtering of contaminated underground waters in relation to the oil drilling activities (Ma, Pan, He, Chen, Fu & Jia, 2012; Moskovchenko, Babushkin & Artamonova., 2009). Other studies evaluated the presence of chemical pollutants in drinking water sources near oil fields. Among the main findings are the high levels of concentration that exceeded reference levels (González, Esteban-Hernandez, Valcárcel, Hernandez-Barrera & de Miguel Gil, 2010), which suggests the direct contamination of the aquifer by exploratory wells, leaks from injection wells and open hole wells (Teng, Feng, Song, Wang & Li, 2013). In contrast, the work by Li, Son and Carlson (2016) revealed no evidence of pollution in the aqueous phase, although these authors suggest that the results are not conclusive, due to data and methodological limitations.

The studies by Kuang, Wu and Zhao (2011) in China measured high concentrations of pollutants in drilling fluids. Other studies focused on measuring concentrations of radioactive materials in areas that were previously used for waste pits and sludge ponds. For example, the study by Spitz, Lovins and Becker (1997) evaluated crop land on a former oil drilling site in Eastern Kentucky. Rajaretnam and Spitz (2000) suggested that the leaching of radium and other radioactive pollutants into the crop lands is another important factor for estimating the risk to human health as the result of oil drilling activities. The work by Hrichi, Baccouche and Belgaied (2013) showed that the samples of waste from regions with oil fields on the Tunisian coast had the highest levels of radium isotopes, with doses of radiation that were higher than the levels considered safe by the United Nations Scientific Committee. However, the study by Jibiri and Amakom (2011) in Nigeria determined that the flow of soil waste did not pose a significant risk to workers or residents in terms of the risk of mortality due to cancer. Exposure to radium could occur by inhaling it on the surface, consuming meat from animals that grazed on the contaminated site or by consuming food grown in these soils.

Furthermore, research has considered the toxicological potential of the fluids used for injection in oil wells to stimulate production, and the waste water collected from these oil wells. Of the 28 chemicals used by oil operators, all are carcinogenic, mutagens, toxic to the reproductive system and development, endocrine disruptors or other extremely toxic chemicals, such as xylene, hydrofluoric acid, methanol and nitriloacetic acid. These compounds can enter the environment through spills, leaks and volatilization (Stringfellow et al., 2017). The degree of contamination, toxicity and phototoxicity caused by the filtration of the production wells and waste water runoff into the water sources was also evaluated in the oil drilling regions of the Amazon rain forest in Ecuador (Wernersson, 2004). However, it was determined that the acute toxicity of the water was low when analyzed by means of bioassays.

Another aspect to bear in mind is environmental disasters caused by spills. The occurrence of spills is associated with the density of oil wells, which indicates that the areas with high well density are more likely to experience spills (Lauer, Harkness & Vengosh, 2016). Oil spills can introduce pollutant compounds into the ecosystem, with long-term effects for aquatic organisms (Cozzarelli et al., 2017). One detailed study of a oil waste water spill found that the levels of chloride and sodium in North Dakota were 10 to 70 times higher than those found before the spill (Lauer et al., 2016).

Singh et al. (2020) showed evidence of the environmental hazard that results from polluting oceans and seas with oil spills, which have increased during the exploration, production, intercontinental transport, storage and consumption of oil, causing a potential threat to nature (Board & Council, 2003). To eliminate these contaminants from the ocean, physical, chemical, thermal and bioremediation techniques are used (Dave & Ghaly, 2011); however, the remediation technologies currently used are still not effective enough to fully restore the polluted marine environment, returning it to its initial state (Singh et al., 2020).

With regard to the factor related to ecosystem health, the biomonitoring of animals can provide information on specific toxic substances in areas exposed to oil drilling processes, given that the animals are continuously exposed to the environmental air, soil and surface waters, they have very short life spans and more frequent reproductive cycles as compared to humans (Johnston et al., 2019). Bamberger and Oswald (2015) investigated 21 cases associated with animal health. In pets and livestock, the effects reported are associated with problems affecting the reproductive, neurological, gastrointestinal and respiratory systems, along with the reduction of growth and milk production. Two studies evaluated heavy metals in the organs of animals raised in oil-producing regions, which were slaughtered for human consumption. In both studies, many of the individual samples

exceeded the allowable levels of lead (Pb) and cadmium (Cd), as established by the European Commission (Brown, 2003; Miedico, Iammarino, Paglia, Tarallo, Mangiacotti & Chiaravalle, 2016). Other authors focused specifically on toxicology studies, where it is shown that exposure to lead (Pb) and cadmium (Cd) negatively affects the reproductive and immunological systems of animals, with effects on the offspring and increased susceptibility to infections (Cai, Long, Zhu, Zhou, Zhang & Liu, 2009). In the study by Wernersson (2004), it was reported that the toxicity of the water was not significantly high at the sites in the area of influence.

Another factor of interest for the academic literature is related to the impact on Public Health. Johnston et al. (2019) embarked on a comprehensive review of the literature on the impacts of oil drilling (exploration and operation) on the environment and human health. With regard to studies related to populational health, aspects have been identified related to diseases and life conditions, from chronic diseases to acute symptoms, cancer, hospitalizations, liver damage, autoimmune disorders, allergies, respiratory problems, overall well-being and quality of life (Ramirez, Arevalo, Sotomayor & Bailon-Moscoso, 2017). Johnston et al. (2019) identified six studies that evaluate the relationship between cancer and oil drilling. However, the results are not conclusive. Some show a high incidence and mortality rate for all types of cancer in the study populations (Hurtig & Sebastián, 2004; 2002). In contrast to this, other authors present results in which no significant relationship was observed between oil production and mortality attributed to cancer (McKenzie, Allshouse, Byers, Bedrick, Serdar & Adgate, 2017).

Other authors identified multiple acute and chronic effects of a non-cancerous nature in communities bordering oil fields. The studies that showed some effect are cited in Dahlgren, Takhar, Anderson-Mahoney, Kotlerman, Tarr and Warshaw (2007), who identified an increased prevalence in different diseases in a community located near the oil operations as compared to another community located farther away from the oil fields. With regard to the consequences for health, various studies have found evidence of alterations in immunological function, which may explain the higher rates of lupus and liver abnormalities (Dey et al., 2015), allergic conditions (Yermukhanova, Zhexenova, Izimbergenova, Turebaev, Bekbauova & Zumabekov, 2017), significant increases in thyroid volume (Kudabayeva, Bazargaliev, Baspakova & Darzhanova, 2014), and neurological symptoms, such as headaches, dizziness, eye and skin irritations and anemia (Kponee, Chiger, Kakulu, Vorhees & Heiger-Bernays, 2015). Nevertheless, the results of the work by Webb, Coomes, Ross and Mergler (2016) failed to identify significant values in the increase of mercury levels in the urine of those living in areas near the drilling site. However, it is important to indicate, in all cases, the dependency of datasets on incomplete information and the missed cases that could influence the study results.

3.3. Social dimension

Social development refers to improvements in the individual and overall well-being of society that result from the increase in social capital, understood as the capacity for individuals and groups of people to work together towards common goals (Munasinghe, 2002). Social capital has both an institutional component and an organizational one. The institutional component refers to the formal laws, as well as the traditional or informal understandings that govern behavior, while organizational component includes the entities (individuals and social groups) that operate within the institutional arrangements. The social dimension of development includes protection strategies that reduce vulnerability, improve equity and ensure that basic needs are met (Munasinghe, 2002). In this case, when the influence of the oil industry on today's society is studied, it is discovered that it is related to many areas of social development, in which many authors have approached topics related to historical aspects, international or geopolitical factors, societal characteristics (culture, demographic change, economic activity, employment) and human capital, training and professional qualification.

Oil conditions to a great extent the fortune of the countries that exploit it as a resource. Those states that produce oil in exportable quantities on a worldwide scale tend to be more powerful than those who do not (Ediger, Selen & Bowlus, 2020). However, there are nuances to this fact and in terms of countries and their relationship to oil, we can identify two large groups: on the one hand, industrialized countries with high levels of consumption of hydrocarbons and thus a highly sophisticated chemical and petrochemical industry; and on the other, developing countries that depend on the income generated by crude oil exports. In other words, the internal consumption of refined products is minimal in economies in which oil is abundant, because they are

industrially underdeveloped; in addition, transportation and living conditions at home do not favor a vast market for refined products; as a result, this weakness in the demand hinders the expansion of the cycle in the refining phases, given that the chain of value for oil requires a significant capital investment and an industry that provides technologically advanced equipment for both phases: upstream (exploration and drilling of crude oil, maritime and/or ground transport) and downstream (refining of crude oil to obtain different derivative products). As a result, almost all oil drilled in developing economies is earmarked for export, and thus is the greatest source of income (Palazuelos, 2016). On the other hand, oil resources are not evenly distributed throughout the world and some countries with vast oil resources generally face instability and political tensions. These problems are important factors in the economic relations between countries supplying and consuming oil (ECA, 2014).

Palazuelos (2016) analyzed the historical conditions of the undeveloped economies that became oil-producing national depending on the income from oil exports, known as rentier economies, based on oil export; these nations are known by the English acronym OBRE. The transformation of these countries into oil-based economies initially offered two main characteristics: The first was related to the political and military subjugation, while the second characteristic was the lack of economic, social and political bases capable of supporting development (Palazuelos, 2016). The so-called OBREs had neither the technological nor the financial capacities to explore and exploit the deposits, and therefore the oil was discovered, drilled, transported and exported by transnational companies belonging to foreign powers (Parra, 2004; Yergin, 1990). In a similar manner, their political institutions showed weakly centralized and barely legitimate authority structures, cult-like leaders with no restrictions in terms of rules, and poor-quality institutions and bureaucracies (Kohli, 2004).

International companies paid royalties to the OBRE countries in compensation for the transfer of operating rights. Said royalties were equivalent to a share of the profits obtained from the sale of the oil. However, the elites who controlled these OBRE countries only needed to dedicate a small portion of the tax income to internal expenditure in order to demonstrate certain economic growth. In general, these expenditures were oriented towards the very consumption of the elite itself, granting subsidies to promote political populism campaigns, increase imported products and the incipient construction of infrastructure. These circumstances favored corruption in the oil sector in the world economies (Erum & Hussain, 2019; Moisé, 2020). The above is related to the economic delay found in these countries.

The unequal geographical distribution of the supply and demand became a relevant factor in global politics (Hirsch, 2008), which helped turn world oil commerce into both a geographic and political matter, with an influence on how its prices were unevenly distributed (Bailey, Hopkins & Wilson, 2010). On the other hand, the volatile nature of resource extraction and the social and economic impacts on communities is a topic of interest among social scientists (Chapman et al., 2015), where aspects like equity and poverty are important issues within the framework of sustainability, and which have social, economic and environmental dimensions (Munasinghe, 2002). The weakening of social values, institutions and the lack of equity reduce the strength of social systems and undermines governance (Munasinghe, 2002).

Some studies focused on the social dislocation caused by the pace of economic expansion and population growth, pointing to social conflicts and difficulties in providing adequate services and housing (Kohrs, 1974; Little, 1977). Later studies focused on a broader collection of interests, with a greater diversity of experiences by individuals and communities (Nord & Luloff, 1993). Among these, socioeconomic well-being (Freudenburg, 1992; Smith, Krannich & Hunter, 2001; Wilson, 2004), local economic adjustment and work (Halseth, 1999) and regional politics (Heisler & Markey, 2013; Markey, Halseth & Manson, 2008) stand out. There are also other aspects related to the importance of reducing vulnerability and maintaining the health of social and cultural systems, and their capacity to withstand shocks (Bohle, Downing & Watts, 1994).

In the United States and Canada, resource extraction was examined in the context of demographic change, economic activity, employment, social cohesion, well-being and environmental management (Ryser, Markey, Manson & Halseth, 2014). Starting in the mid-2000s, Australian researchers, in turn, began to take interest in the impacts of the resource boom (Shann, 2012), since the conditions of many rural and remote communities have been linked for some time to the extraction of mineral and energy resources (Lawrie, Tonts & Plummer, 2011). Some of the challenges that stand out are related to the fast pace of development; the way in which mining

changes demographics, with populations that move or travel from non-mining areas to work in mining areas, causing a demographic imbalance, since they are mainly young single men (Kotey & Rolfe, 2014), which has an impact on the growing demand for housing, infrastructure and services (Ennis, Finlayson & Speering, 2013; McKenzie, Phillips, Rowley, Brereton & Birdsall-Jones, 2009), increased cost of living (Haslam McKenzie & Rowley, 2013), social dislocation and unsettling (Cameron, Lewis & Pfeiffer, 2014) and increased social inequality (Reeson, Measham & Hosking, 2012). Another important aspect are the implication of the forced fly-in/fly-out (FIFO) working arrangements in mining, which some believe to deplete the economic and social activity in the regional communities (Australia, 2013).

The work by Smith et al. (2001) considers several dimensions of social well-being in four western rural communities, applying populational surveys four times over the course of 13 years. The results show that while social interruptions occur in several dimensions of well-being during boom periods, not all dimensions appear to be affected by this growth. Furthermore, when a reduction in well-being occurs that is triggered by the boom, it is consistently followed by a strong rebound, with no evidence of a long-lasting interruption (Smith et al., 2001). However, it is also clear that resource-based communities are diverse and their experiences vary considerably, depending on their location, the type of product, the company structure and the underlying socioeconomic structure (Chapman et al., 2015; Lawrie et al., 2011).

Authors in the social field have considered the contribution made by the mining activity to improving human capital through education, the strengthening of social values and institutions (Sun et al., 2020). As proposed by Kotey and Rolfe (2014), in order to bear the technical requirements of work in the mining sector, technical, commercial and machine occupations would be predominant, as would occupations in sectors providing business services to the mining industry, which are also influenced and require greater professionalization. Petkova, Lockie, Rolfe and Ivanova, in turn, (2009) reported that in spite of complaints about the lack of skills, businesses in the mining areas developed strategies to access the relevant skills, used local manpower, brought in workers from abroad or provided very favorable employment conditions.

Authors like Gylfason (2001) indicate that the countries that did not focus their investment on human capital were unable to free themselves from dependence on primary products, which limits diversification in their economies. In the case of Finland and South Korea, industrial development shifted an economy based on basic products toward one driven by exports. This points to the link between human capital and economic development (Sun et al., 2020). Rajan and Zingales (2003) identify financial expansion as the basis to turn the resource curse into a blessing, though a strong institutional quality, highly qualified workers and trade with other countries. Lederman and Maloney (2007) and Gylfason (2001) found that the benefits of international trade are only achieved through quality human capital that promotes financial development. However, the relationship between human capital and investment in education has not been studied in countries with different levels of education (Sun et al., 2020).

Douglas and Walker (2017) found that in the United States, there is a positive link between educational expenditures and the abundance of high-return resources. The higher income is due to the abundance of resources, the greater the expenditure is on education; but not all regions or countries follow this maxim. In some cases, it was found that resources cause delays in education. In accordance with this, Sibel, Kadir and Ercan (2015) conclude that financial development in Turkey can be significantly promoted thanks to the improvement in education and the training of workers. It is important to stress that human capital in China has undergone an evident improvement, attributable to the increase in educational level, particularly after 1985. Mass urbanization and economic transition have accumulated human capital in urban areas. In addition, better education and job opportunities in Chinese cities supported the accumulation and development of workers (Jarvis et al., 2011).

3.4. Sustainability factors identified

This section summarizes the sustainability factors identified in the bibliographic review. As mentioned at the start, when we mention factors of sustainability, we refer to categories that allow us to study and analyze in greater detail each of the three dimensions of sustainability. See Figure 2.
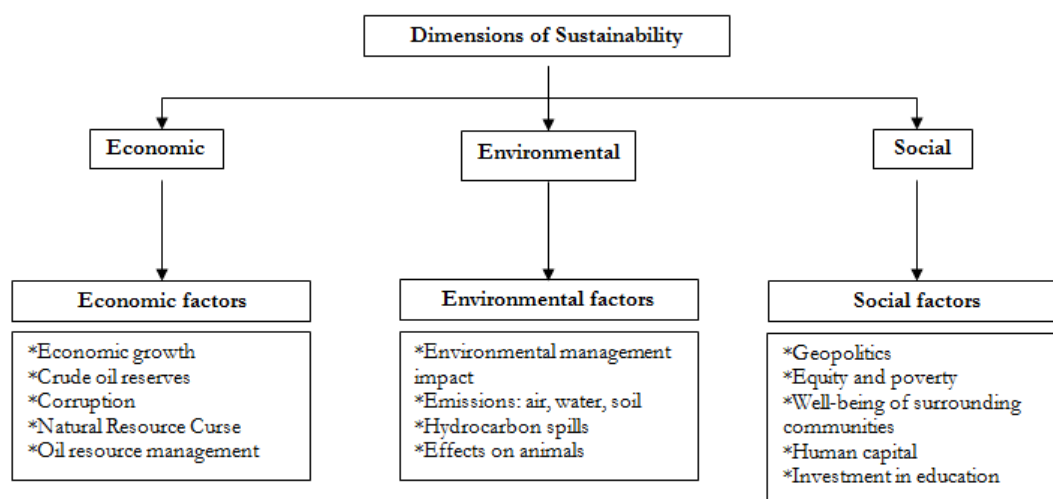
Figure 2. Conceptual map of the sustainability factors identified

4. Discussion

The literature review shows that the oil industry has many benefits for the economic development of the regions, and it also molds modern society in significant ways, even though many are unaware of this. However, in spite of its unquestionable role in the development of modern society, it is a widely questioned sector. Its drilling and consumption generates controversy with regard to its impact on the economic growth of the regions where the resource is extracted, so much so that some authors have proposed and studied the hypothesis of the natural resource curse (Sun et al., 2020). The results in this regard are less than conclusive, since in contrast to this, other authors have empirically demonstrated the positive impacts for the economic growth of some oil producing regions (Topcu et al., 2020). The studies mentioned in relation to the resource curse only study the phenomenon in an isolated manner and fail to include other variables that could be related to slow economic growth, such as poor institutional development, weak financial systems, low levels of investment in education and technological delays, etc. The oil reserves in a particular region do not represent a blessing or a curse in and of themselves, which goes to show that it is the cultural and social backdrop that determines how societies manage the resources they have.

Meanwhile, countries that have oil resources, in which these would appear to be a curse, have similar sociocultural characteristics, such as low or non-existing levels of democracy, high levels of corruption, governance under some sort of regime (socialist or theocratic), low or non-existent economic diversification, little economic and political freedom, a low educational level and deficient institutional development. By contrast, the countries that have oil resources and where these are considered a blessing are the opposite side of the coin in terms of sociocultural characteristics. These countries can be considered free, open economies, with a high level of institutional development, democracy, high-quality education and low levels of corruption.

Another important aspect related to the economic dimension is the depletion and replacement of crude oil. Its replacement as an energy source is not considered plausible over the medium-term, among other reasons, because crude oil is not only used to generate energy, it is also an important source of raw materials for all types of industries. It is expected that the resource will eventually be depleted, although it is difficult to predict and most forecasts have failed in this regard. Replacements for conventional crude oil are already being explored and exploited, among which are heavy crude oil, extra-heavy crude oil, tar sands, etc. These hydrocarbons are much more abundant that those currently being exploited and are profiled as the most likely source of energy transition. It is precisely for this reason that it is extremely important to consider the sustainability of the hydrocarbon industry, because these new resources bring with them new challenges, mainly in the environmental dimension.

The environmental impacts of oil are very evident and affect the air, soil, water and sediments. However, their magnitude and hazardousness are primarily materialized in countries with few controls and with deficient

legislation. In non-academic public opinion, the problem is very stigmatized and it is assumed that the oil industry is synonymous with ecological destruction. However, the truth is that many studies that have been conducted cannot generate specific evidence and lack associated studies that can establish causal relationships. When there are accidents and spills, the damage is evident, but during normal operations at facilities that operate under environmental control standards, they can have a very reduced impact on the environment. The problem is that these details are unknown by public opinion, which focuses on the images in the press that show the aftermath of accidents. It is important to stress that the magnitude of the environmental impacts of the oil sector can be reduced to a minimum, as long as there is efficient institutional control, advanced technology and adequate environmental management. In environmental terms, it is possible to achieve sustainability as long as there is an appropriate legal, institutional and incentive framework.

Finally, the social dimension in relation to the oil sector is one of the most sensitive dimensions, given that the sociocultural aspects, customs and mentality of a particular society can have a significant influence on the other two dimensions (economic and environmental) of sustainability. Most of the studies reviewed that consider this matter are focused on the problems associated with its influence on political stability, institutional quality, policy formation and the robustness of the financial system. The petroleum sector has enormous potential for strengthening the social fabric if the resources are reinvested in improving the quality of education, the qualification of the workforce and supporting related economic activities. Nevertheless, many studies indicate that the countries that do not invest in human capital continue to depend on primary products, limiting the diversification of their economies.

5. Conclusions and future lines of research

The sustainability analysis of the oil industry is a highly relevant matter, given that it is one of the most representative sectors in current society, due to the enormous influence it has and its power to shape society. However, the topic poses difficulties when it is approached from a simplistic perspective. As a matter of fact, the most relevant findings of this review highlight that in spite of the large volume of works related to the oil industry in the databases consulted in Scopus and Science Direct, no recent studies were found on the impact of the activities in this industry on the three dimensions of sustainability, considered from a holistic, comprehensive perspective. The lack of these studies probably owes to the very broadness of the topic and by the interest of authors in highlighting or delving deeper into a specific aspect, which is certainly valid. That said, it is necessary to undertake more holistic studies that allow us to show a broader perspective, which is crucial for decision-making.

Sustainability takes into account three dimensions: economic, environmental and social, where each is very broad when analyzing the oil industry from its perspective. The result of the review shows that there is a variety of studies focused on only one of the dimensions, others which are case studies in specific situations and contexts in which it would be difficult to generalize the conclusions reached. The studies found can hardly be compared to one another, since they evaluate different variables, criteria and analysis categories, and they also consider different sustainability factors.

The main contribution of this study, besides the comprehensive review of the literature, is the identification and characterization of the sustainability factors in order to evaluate the sustainability of the oil sector. In the economic dimension, the most representative factors were the reserves or availability of crude oil, corruption, economic growth, natural resource curse, and oil resource management. In the environmental dimension, the factors identified are the impact and environmental management, emissions into the air, water and soil, drilling sludge, hydrocarbon spills, effects on animals and impact on human health. Finally, in the social dimension, topics are analyzed in relation to political elites, equity and poverty, the well-being of neighboring communities, human capital and investment in education.

Based on the findings presented in this article, it is possible to identify new paths for research into topics that have not yet been considered and based on it, devise new lines of research. In this vein, the characterization is proposed of factors that have not previously been considered, such as hydrocarbons, which have not been contemplated, but which are important to study from the perspective of sustainability and which have been studied in other areas of sustainable development, such as CEPAL, for example. In the economic dimension,

other factors to consider would be those related to efficiency, the institutional framework, economic structure, institutional capacity, revitalization of other sectors and how royalties are handled. In terms of the environmental dimension, factors could be considered in relation to improvements in technologies, environmental control technologies, and socio-environmental conflicts. Finally, with regard to the social dimension, factors such as security, governance, infrastructure, employment and support for SMEs (Small and medium-sized enterprises) have been suggested.

Another future line of research would be the need to consider comparative works that would make it possible to make associations between the dimensions of sustainability and risk factors typical of the oil industry. In a similar manner, it is necessary to consolidate cross-sectional and transdisciplinary lines of research in order to analyze the information from different perspectives. One example would be in the area of environmental health, an interdisciplinary field belonging to the environmental, social and health sciences, the focus of which could enrich the analysis of the sustainability of oil in specific contexts. It would also be interesting to conduct epidemiological studies, the aim of which would be to obtain and analyze individual measurements in populations in order to establish a clear relationship between pollutants and the health of residents in oil producing regions. Another type of relevant study is related to the technologies and mechanisms used by companies for environmental control and the new developments that they can explore to reduce impacts. In the social realm, studies are lacking with a combined focus (qualitative-quantitative), with a well-structured ethnographic component, in which there are categories of analysis that make it possible to investigate positive and negative aspects on the industry in a particular region. In general, to date the existing studies have focused on collecting information about and emphasizing problems. In order to take a step further and propose solutions, it is important for studies to assume more critical perspectives. The relevance of the topic and the urgency to find sustainable energy sources opens doors to new opportunities for research, in which interdisciplinary work can be fostered among the economic, social and environmental sciences.

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Appendix A: Key paper

The Table presents the 31 most relevant Key papers for the economic development dimension; some of these articles are repeated in the other two dimensions.

Author	Aim	Analysis method	Years of analysis	Factor	Region	Economic dimension	Environmental dimension	Social dimension
Ahmed et al. (2020)	Analysis of the effect of the abundance of natural resources, human capital and urbanization on the ecological footprint and economic growth in China	Bayer and Hanck and bootstrap causality technique	1970-2016	Environmental management	China		X	X
Ediger et al. (2020)	Perception of the oil sector and its relationship to power in Turkey and Jordan	Documentary case study analysis	1980-2018	Oil reserves	Turkey and Jordan	X		
Moisé (2020)	Study on corruption in the oil sector in world economies	Systematic study of the literature	1978-2018	Corruption	Global	X		X
Norouzi et al. (2020)	Scenario planning to forecast the peak of oil reserves	Hubert's forecasting method (based on the Monte Carlo non-linear prediction regression)	2000-2070	Oil reserves	Global	X		
Singh et al. (2020)	Study on the environmental impacts of oil spills in the maritime world and the removal of spilled oil from the water by means of magnetic nano-absorbents	Review of the literature	No restrictions	Oil spills	Global		X	
Sun et al. (2020)	Study on financial development, considering the depth, accessibility and efficiency of the markets and financial institutions	Comprehensive index for financial development	1990-2017	Economic growth	Seven emerging economies (E-7)	X		X
Topcu et al. (2020)	Analysis of the effects of natural resources, energy consumption and the gross accumulation of capital on economic growth	Panel Vector Autoregression Analysis (PVAR)	1980-2018	Economic growth	124 countries	X		

Author	Aim	Analysis method	Years of analysis	Factor	Region	Economic dimension	Environmental dimension	Social dimension
Armeanu et al. (2019)	Study on the impact of energy consumption and environmental pollution on economic growth	Panel data regression models	2000-2016	Environmental pollution	11 countries in Central and Eastern Europe		X	
Johnston et al. (2019)	Study on the impacts that oil drilling operations can have on human health and environmental hazards	Review of the literature	1993-2017	Impacts on human health	20 countries around the world: Australia, Bolivia, China, Colombia, Ecuador, India, Iran, Iraq, Italy, Kazakhstan, Kuwait, Nigeria, Oman, Peru, Russia, Trinidad and Tobago, Tunisia and the United States		X	
Yasmeen et al. (2019)	Study on the relationship between oil price fluctuations and the growth of the real sector in Pakistan	Classic normal linear regression models under autoregressive distributed lag (ARDL)	1976-2017	Economic growth	Pakistan	X		
Zaidi et al. (2019)	Study on the impact of globalization, natural resources and human capital on financial development through control over the effect of economic growth and capital in OCDE countries	Second-generation econometric techniques	1990-2016	Economic growth	31 countries of the OCDE	X		
Ahmed, Mahalik and Shahbaz (2016)	This study incorporates economic growth as a function of natural resources, exports, capital and manpower	Time series study in a Cobb-Douglas production function	1965-2011	Natural resource curse	Iran	X		

Author	Aim	Analysis method	Years of analysis	Factor	Region	Economic dimension	Environmental dimension	Social dimension
Palazuelos, (2016)	Developing of a framework to evaluate the performance of oil-based rentier economies	Review of the literature	No restrictions	Natural resource curse	OBRE countries	X		X
Zou et al. (2016)	Predicting the future situation of global energy development	Predictions of world energy development	1986-2040	Oil management and energy strategies	Global	X	X	
Chapman et al. (2015)	Exploring the experiences of local residents and perceptions of change in two cities that depend on resources in the Pilbara region of Western Australia	Q methodology study	No restrictions	Characteristics of society (culture, demographic change, economic activity, employment)	Western Australia			X
Kotey and Rolfe (2014)	Analyzing the impact of mining in local areas of Australia, comparing miners and non-miners and investigating the changes that emerge in the two types as a result of the resource boom	Multivariate analysis of variance	2006-2011	Characteristics of society (culture, demographic change, economic activity, employment)	Australia			X
Satti et al. (2014)	Investigating the relationship between the abundance of natural resources and economic growth on the Venezuelan economy	ARDL bounds test for exploring co-integration	1971-2011	Natural resource curse	Venezuela	X		
Abbaszadeh et al. (2013)	Examining the energy status of Iran	Scenario development method	2000-2025	Oil management and energy strategies	Iran	X		
Abou-Ali and Abdelfattah (2013)	Studying the relationship between the availability of natural resources, economic growth and the environment	Principal component analysis and compound indicators	1990-2007	Natural resource curse	62 countries	X		X
Bahrami and Abbaszadeh (2013)	Exploring the overview of renewable energies in Iran	Documentary analysis	No restrictions	Oil management and energy strategies	Iran	X		

Author	Aim	Analysis method	Years of analysis	Factor	Region	Economic dimension	Environmental dimension	Social dimension
Hamdi and Sbia (2013)	Examining the dynamic relationships between oil income, public expenditure and economic growth in the Kingdom of Bahrain	Model and data from co-integration analysis and correction of multivariate errors	1960-2010	Blessing of natural resources	Kingdom of Bahrain	X		
Becken (2011)	Conducting a critical meta-analysis to evaluate current knowledge of 'tourism and oil'	Meta-analysis	No restrictions	Characteristics of society (culture, demographic change, economic activity, employment)	Countries with the highest percentage of expenditure on tourism			X
Cavalcanti et al. (2011)	Exploring whether the abundance of natural resources is a curse or a blessing	Econometric model	1980-2006	Economic growth	53 countries	X		
Hall et al. (2003)	Studying the relationship between hydrocarbons and the evolution of human culture	Documentary analysis	No restrictions	Economic growth	Global	X		X
Gylfason (2001)	Study on natural resources, education and economic development	Dispersion diagram of economic growth	1965-1998	Curse of natural resources	86 countries	X		X
Munasinghe (2002)	Establishing the key elements of sustainability	Meta-marco	No restrictions	Economic growth and sustainability	Global	X		X
Munasinghe (2001)	Integrates optimization and durability into the analysis of climate change	AIM framework	No restrictions	Economic growth and sustainability	Global	X		
Tharakan et al. (2001)	Examining the temporal trends of three efficiency indicators in order toevaluate whether industrial development has led to greater efficiency in the use of resources and a related reduction in the total use of resources and environmental impacts	Trends over time	1961-1995	Economic growth and sustainability	5 Asian countries: China, India, Indonesia, Japan and Pakistan	X		

Author	Aim	Analysis method	Years of analysis	Factor	Region	Economic dimension	Environmental dimension	Social dimension
Campbell and Laherrère (1998)	The study proposes the reduction of world production of conventional oil.	Documentary analysis	Does not specify	Oil management and energy strategies	Global	X		
Sachs and Warner (1997)	Exploring the possible routes for a negative relationship by studying the effects among countries of the provision of resources on trade policies, bureaucratic efficiency and other determinants of growth	Simple theoretical model of endogenous growth	1971-1989	Natural resource curse	Global	X		
Corden (1984)	Reviewing and consolidating the growing literature on the boom sector economics and the Dutch disease	Documentary analysis	No restrictions	Natural resource curse	Global	X		

Table A1. Key papers identified for the regional economic development dimension